White Paper

Maximizing Storage Capacity

kardex remstar

Introduction

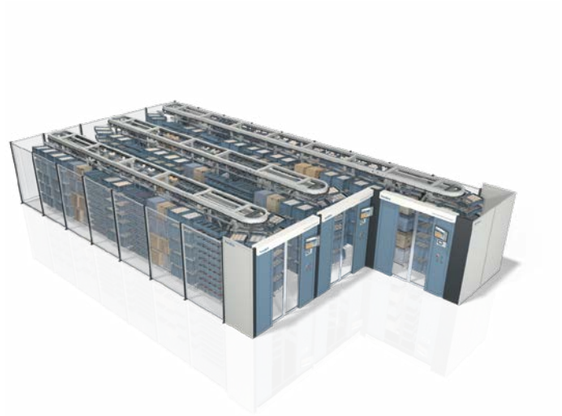
Rare is the manufacturing, warehousing or distribution facility that does not suffer from some amount of space limitations. Sometimes inventory, parts or work-in-process have exceeded current capacity. Or perhaps the footprint of the facility prevents the addition of more storage equipment without an expensive addition of more square footage through construction. Either way, space is nearly always at a premium.

For facilities that rely on traditional shelving[1]—made of upright posts, formed steel sheet panels as horizontal shelves and end and back braces or sheet steel back and side panels for support—for storage of non-palletized loads, automated storage and retrieval systems (ASRS) are available as an alternative. These self-contained systems offer higher density storage in a more compact footprint than manual equipment can provide. Four primary types include:

Horizontal Carousel Module (HCM)

Consisting of bins mounted on an oval track that rotate horizontally to deliver stored items to an operator. These automated storage and retrieval systems save up to 60% of floor space when compared to standard shelving and rack.

Learn more about HCMs.



Vertical Carousel Module (VCM)

Comprised of a series of shelves that rotate around a track—similar to a Ferris wheel—these automated storage and retrieval systems quickly deliver stored items to an ergonomically positioned work counter at the operator's command. When compared to static shelving and rack, they save up to 75% of floor space.

Learn more about VCMs.

Vertical Lift Module (VLM)

An enclosed automated storage and retrieval system that incorporates two columns of trays with a central inserter/extractor that automatically locates and retrieves stored trays from both columns, then presents them to the operator at a waist-high pick window. These systems save up to 85% of floor space compared to static shelving and rack.

Learn more about VLMs.

Vertical Buffer Module (VBM)

In the middle of a multi-segment shelving system is an aisle, where a moveable mast with a telescopic gripper operates. The control unit sets the gripper in motion picking a bin and transporting it to a picking station.

Learn more about VBMs.

Benefits of ASRS

Each type of automated storage methodology offers different benefits in comparison to traditional, static shelving, including the amount of space/footprint required and ease of expansion, as shown in Table 1.

Table 1: Storage system comparison ranked by their benefits.
Ranking: 5 = best, 4 = great, 3 = better, 2 = good, 1 = fair

Benefits	Shelving	HCM	VCM	VLM	VBM
Space / Footprint	1	4	5	5	4
Expandability	5	4	3	4	3

Implementing one of the four types of high-density ASRS immediately reduces the amount of square footage required by shelving to store items. These space efficiencies can be further leveraged either through the storage of more products in the same amount of facility footprint, or via an expansion in the number of SKUs stored.

Storage capacity comparison

One way to compare automated storage and retrieval technologies to shelving is based on the available capacity within each system. A capacity comparison reveals how many sections of shelving fit into an ASRS, quantifying storage density within the unit.

To do these calculations, assumptions have to be made as to space utilization within the unit. Assumptions also have to be made about the size of the system. For the purposes of this white paper, common installation sizes were used to compare capacities. Before comparing shelving to the various automated technologies, we first must determine the capacity of a standard section of shelving.

Standard industrial shelving capacity

- Assuming 7 shelves per shelving section
- Unit specifications:
  3 ft wide × 1.5 ft deep × 6.35 ft tall = 28.58 ft^3 of storage space per shelving unit
- Assuming 30% utilization of shelving = 8.58 ft^3 of storage space per shelving unit.
  Now we have determined each section of shelving provides 8.58 ft^3 of storage space.
  We can compare this to the available capacity of each ASRS.

Horizontal Carousel Module capacity

- Carrier specifications = 2.05 ft wide × 2 ft deep × 7 ft tall = 28.7 ft^3
  (cubic storage space per carrier)
- Number of carriers per HCM: 22
- 28.7 ft^3 × 22 carriers = 631 ft^3 (cubic storage space per unit)
- 631 ft^3 × 2 HCMs = 1,262 ft^3
- Assuming 62% utilization of HCMs = 782 ft^3
- Two, 22 bin HCMs provide 782 ft^3 of storage capacity
- To calculate capacity savings in cubic feet: 782 ft^3/8.6 ft^3 = 90.9

Calculation result: 90 sections of shelving fit into two, 22 carrier HCMs

Vertical Carousel Module capacity

- Carrier specifications = 10 ft wide × 2 ft deep × 1.16 ft tall = 23.2 ft^3 (cubic storage space per carrier)
- Number of carriers per VCM: 18
- 23.2 ft^3 × 18 carriers = 418 ft^3 (cubic storage space per unit)
- Assuming 75% utilization of VCM = 326 ft^3
- One 16 ft tall VCM provides 326 ft^3 of storage capacity
- To calculate capacity savings in cubic feet: 326 ft^3/8.6 ft^3 = 37.9

Calculation result: 37 sections of shelving fit into one 16 ft tall VCM

Vertical Lift Module capacity

- Unit height = 22.69 ft
- 5.9 in tray spacing allows 71 trays for storage (front and back storage with room for access opening)
- Average product height per tray = 5.12 in (0.426 ft)
- Tray dimensions = 8.04 ft wide × 2.83 ft deep × 0.426 ft tall = 9.7 ft^3 (cubic storage space per tray)
- 9.7 ft^3 × 71 trays = 689 ft^3 (storage space per unit)
- Assuming 75% utilization of VLM = 516 ft^3
- One 23 ft tall Shuttle VLM provides 516 ft^3 of storage capacity
- To calculate capacity savings in cubic feet: 516 ft^3/8.6 ft^3 = 60.0

Calculation result: 60 Sections of shelving fit into one 23 ft tall VLM

To further maximize cubic density, VLMs permit dynamic allocation of trays for variable increment storage heights inside the machine—rather than limiting each tray to a fixed height storage space. Equipped with an automated hardware and control system, the VLM incorporates a sensor which measures the height profile of each storage tray's contents as it passes onto the lift platform. The control system then determines the best storage location in the unit based on the least amount of space used within the fastest retrieval position. This function permits storage trays to be placed within 1 inch of each other, providing up to an additional 50 percent of storage capacity per unit. This technology has been factored into the capacity calculations above.

Vertical Carousel Module

Vertical Lift Module

Vertical Buffer Module capacity

- Unit height = 22.97 ft
- Tote product storage dimensions = 2.00 ft length × 1.35 ft width × 1.02 ft height
- This Kardex Miniload-in-a-Box* unit can hold 390 totes of this size
- 2.00 ft × 1.35 ft × 1.02 ft = 2.75 ft^3
- 2.75 ft^3 × 390 totes = 1,073 ft^3 (storage space per unit)
- Assuming 75% utilization of VBM = 804 ft^3
- One 23 ft tall Kardex Miniload-in-a-Box (VBM) provides 804 ft^3 of storage capacity
- To calculate capacity savings in cubic feet: 804 ft^3/8.6 ft^3 = 93

Calculation result: 93 sections of shelving fit into one 23 ft tall VBM

Kardex VBM Box

* formerly Kardex Compact Buffer

Floor space savings comparison

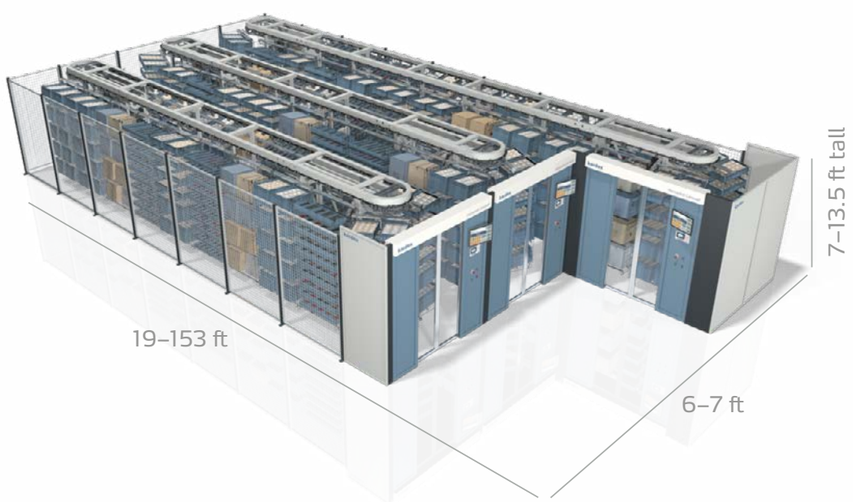
Another way to compare these technologies is based on floor space, measured in square feet. As a general rule of thumb, when compared to standard shelving, HCMs save up to 60 percent of floor space, VCMs save up to 75 percent of floor space, VLMs save up to 85 percent of floor space and VBM save up to 80 percent of floor space.

As with capacity, when comparing floor space savings, certain assumptions need to be made, such as aisle space and access space. For purposes of these calculations, 3.5 feet of aisle space and 4 feet of access (or turnaround) space have been assumed.

HCM floor space savings

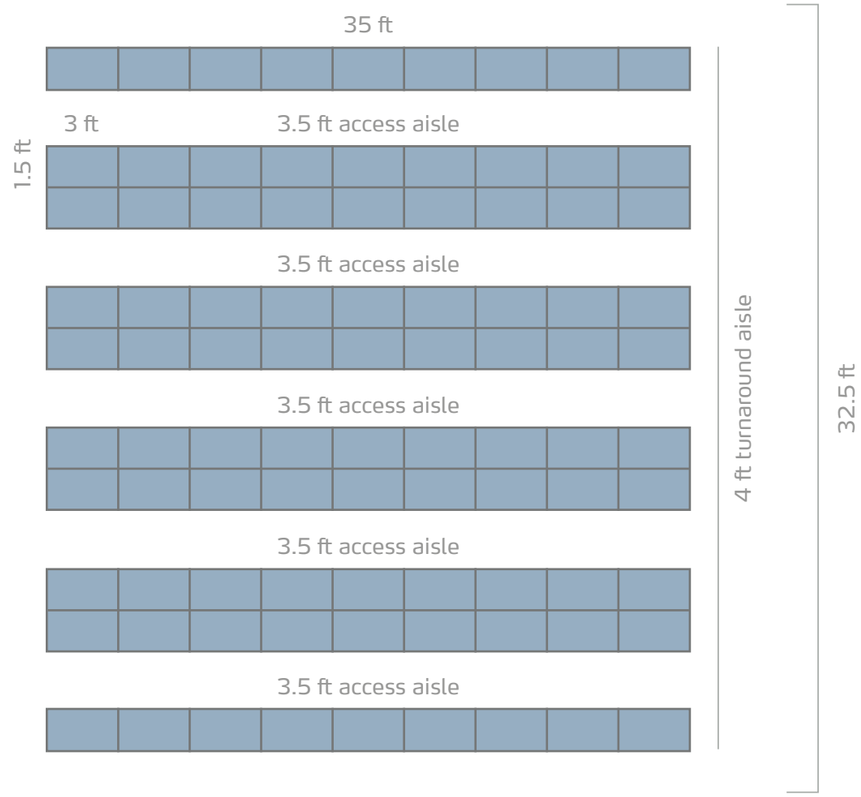
To determine the equivalent capacity of standard shelving to a HCM, first determine how many shelves of inventory can fit into a typical machine (approximately 16 feet tall). Assumptions are included within the calculations, which also take into account the width of standard access aisles required for access to the storage medium.

Horizontal Carousel Module
- Unit width: 6.22 ft × 2 carousels = 12.44 ft, plus 1 ft space between carousels and 0.5 ft on each side= 14.44 ft
- Length (22 carrier unit): 26.75 ft, plus 4 ft access = 30.75 ft
- Horizontal Carousel Module floor space occupied: 14.44 ft wide × 30.75 ft long = 444 ft^2



90 shelving sections
- Width: 3 ft with 4 ft turnaround
- Depth: 1.5 ft with 3.5 ft aisle access
- Width: (3 ft wide × 9 bays) + (2 × 4 ft aisle)= 35 ft wide
- Depth: (1.5 ft deep × 10 sections) + (5 × 3.5 ft aisle) = 32.5 ft deep
- Shelving floor space occupied: 35 ft × 32.5 ft = 1,137 ft^2
- To calculate floor space savings in sq ft:
  1,137 ft^2 – 444 ft^2 = 693 ft^2 /1,137 ft^2 = 0.60

Calculation result: Horizontal Carousel Modules save 60% floor space!



VCM floor space savings

To determine the equivalent capacity of standard shelving to a VCM, first determine how many shelves of inventory can fit into a typical unit.

Vertical Carousel Module
- Unit specifications: 12 ft wide × (5.5 ft deep + 5 ft access area = 10.5 ft) = 126 ft^2

36 shelving sections
- Width: 3 ft with 4 ft turnaround
- Depth: 1.5 ft with 3.5 ft aisle access
- (3 ft wide × 6 bays) + (2 × 4 ft aisle)= 26 ft wide
- (1.5 ft deep × 6 sections) + (3 × 3.5 ft aisle) = 19.5 ft wide
- Shelving floor space required: 26 ft × 19.5 ft = 507 ft^2
- To calculate floor space savings in Sq Ft:
  507 ft^2 – 126 ft^2 = 381 ft^2 /507 ft^2 = 0.75

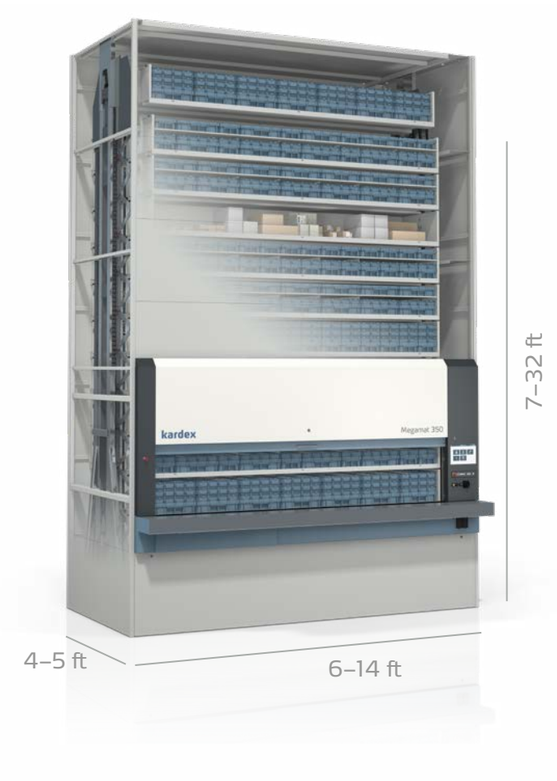
Calculation result: Vertical Carousel Modules save 75% floor space!

Combining floor space savings with capacity savings

Further, applying the capacity numbers from above can determine how much additional cube is provided. It was determined that each section of shelving provided 8.6 ft^3 of capacity, while each VCM carrier provided 23.2 ft^3 of capacity.

- 8.6 ft^3 per shelving section × 36 shelving sections = 309 ft^3 of storage capacity
- 23.2 ft^3 per vertical carousel carrier × 18 carriers = 417 ft^3 of storage capacity
- To calculate additional capacity in cubic Feet: 417 ft^3 - 309 ft^3 = 108/417 = 0.25

Not only can Vertical Carousel Modules save 75% floor space, they provide 25% additional capacity.



VLM floor space savings

To determine the equivalent capacity of standard shelving to a VLM, first determine how many shelves of inventory can fit into a typical VLM (approximately 23 feet tall).

Vertical Lift Module
- Unit specifications:
  9.12 ft wide × (10.09 ft deep + 3.5 ft access area = 13.59 ft deep) = 124 ft^2

60 shelving sections
- Width: 3 ft with 4 ft turnaround
- Depth: 1.5 ft with 3.5 ft aisle access
- (3 ft × 6 sections) + (2 × 4 ft access aisle) = 26 ft wide
- (1.5 ft × 10 sections) + (5 × 3.5 ft aisle) = 32.5 ft deep
- Shelving floor space required: 32.5 ft × 26 ft = 845 ft^2
- To calculate floor space savings in Sq Ft: 845 ft^2 – 124 ft^2 = 721 ft^2 /845 ft^2 = 0.85

Calculation result: Vertical Lift Modules save 85% floor space!

Combining floor space savings with capacity savings

Further, applying the capacity numbers from above can determine how much additional cube is provided. It was determined that each section of shelving provided 8.58 ft^3 of capacity, while each VLM tray provided 9.7 ft^3 of capacity.

- 8.6 ft^3 per shelving section × 60 shelving sections = 516 ft^3 of storage capacity
- 9.7 ft^3 per VLM tray × 71 carriers = 689 ft^3 of storage capacity
- To calculate additional capacity in cubic feet: 689 ft^3 - 516 ft^3 = 173/689 = 0.25

Not only can Vertical Lift Modules save 85% floor space,
they provide 25% additional capacity.

VBM floor space savings

To determine the equivalent capacity of standard shelving to a Kardex Horizontal Carousel, first determine how many shelves of inventory can fit into a typical Vertical Buffer Module 23 feet tall. Assumptions are included within the calculations, which also take into account the width of standard access aisles required for access to the storage medium at both the turntable and maintenance ends.

Vertical Buffer Module
- Unit width: 7.71 ft, plus 0.5 clear = 8.21 ft
- Unit length = 39.49 ft + 3.5 ft pick area + 3.5 ft maintenance = 46.49 ft
- Vertical Buffer Module floor space occupied: 8.21 ft wide × 46.49 ft long = 382 ft^2

90 shelving sections
- Width: 3 ft with 4 ft turnaround
- Depth: 1.5 ft with 3.5 ft aisle access
- Width: (3 ft wide × 9 bays) + (2 × 4 ft aisle) = 35 ft wide
- Depth: (1.5 ft deep × 10 sections) + (5 × 3.5 ft aisle) = 32.5 ft deep
- Shelving floor space occupied: 35 ft × 32.5 ft = 1,137 ft^2
- To calculate floor space savings in square feet:
  1,137 ft^2 – 382 ft^2 = 817 ft^2 /1,137 ft^2 = 0.72

Calculation result: Vertical Buffer Modules save 72% floor space!

To learn more about the increased cubic capacity and floor space savings you can expect to gain from an investment in Horizontal Carousel Module, Vertical Carousel Module, Vertical Lift Module or Vertical Buffer Module technologies as a replacement for static industrial shelving, use our project justification calculator.

Calculate online now

Space savings in action: Kubota

OEM parts supplier saves 71% floor space with Horizontal Carousel Modules; 83% floor space with VLMs

With a commitment to keeping replacement parts available for 20-plus years to support their full line of tractor and utility vehicles, Kubota Canada Ltd.'s Markham, Ontario distribution center was challenged to store more than 78,000 SKUs in a 60,000 square foot facility. In order to maximize storage density in a minimum footprint, the company implemented automated storage and retrieval technologies in phases.

In the first phase, Kubota purchased six Horizontal Carousel Modules from Kardex to replace a three-story mezzanine that occupied 3,000 sq ft per floor (9,000 sq ft of inventory storage total). Including a workstation, picking area and six, 24-foot-long HCMs the system occupies 2,600 sq ft—71 percent less floor space than the mezzanine. Additionally, all the parts are now stored on a single floor, enabling a single operator to pick parts ergonomically and more than 90 percent faster without walking up and down stairs.

Instead of considering a building expansion, the company installed Vertical Lift Modules from Kardex as part of the second phase of the picking system implementation. The first two Kardex Shuttle replaced 2,400 sq ft of 18-foot-high bay shelving. Shortly thereafter, two more VLMs were installed to replace 1,200 sq ft of 24-foot-high bay shelving. In this zone, the workstation, picking area and four Kardex Shuttle now occupy 620 sq ft, allowing Kubota to free up just under 3,000 sq ft of floor space for an increase in parts capacity—and 83 percent floor space savings. In addition to increased part capacity and improved ergonomics, picking productivity in the VLM zone has doubled simply by eliminating travel time to part locations.

The investment in automated storage and retrieval systems has enabled the facility to accommodate 70 percent growth over the past 12 years with minimal increases to its labor force. Further, the current ASRS has enough remaining capacity to allow the facility to sustain this rate of growth for an additional five to eight years.

About Kardex

Kardex is a global industry partner for intralogistics solutions and a leading supplier of automated storage solutions and material handling systems. The Group consists of two entrepreneurially managed divisions, Kardex Remstar and Kardex Mlog.

Kardex Remstar develops, produces, and maintains dynamic storage and retrieval systems and Kardex Mlog offers integrated materials handling systems and automated high-bay warehouses.

The two divisions are partners for their customers over the entire life cycle of a product or solution. This begins with the assessment of customer requirements and continues through planning, realization, and maintenance of customer-specific systems. It ensures a high level of availability combined with low total cost of ownership and operation.

Bibliographical references

1. Material Handling Industry, "Glossary>Shelving," accessed June 19, 2019, http://mhia.org/learning/glossary/s#shelving.